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(54) Method and device for handling cellulose pulp

(57) By shredding of the pulp to a finely divided dry granulate, dilution to a homogeneous consistency in the medium consistency range can take place exclusively through hydrodynamic effects from the addition of dilution fluid. The dilution fluid is added to the granulate at a position at which the granulate is in free fall in a stand pipe 22, 40 and above a level Liq_{LEV} of diluted pulp in the stand pipe. A number of nozzles are arranged around the periphery of the stand pipe, directed in towards the centre of the stand pipe, obliquely downwards in the direction of fall of the granulate.

It is possible through this simplified procedure to avoid completely the conventional dilution screws, and this reduces the investment costs and operating costs, while at the same time unnecessary mechanical influence of the pulp fibres can be avoided.

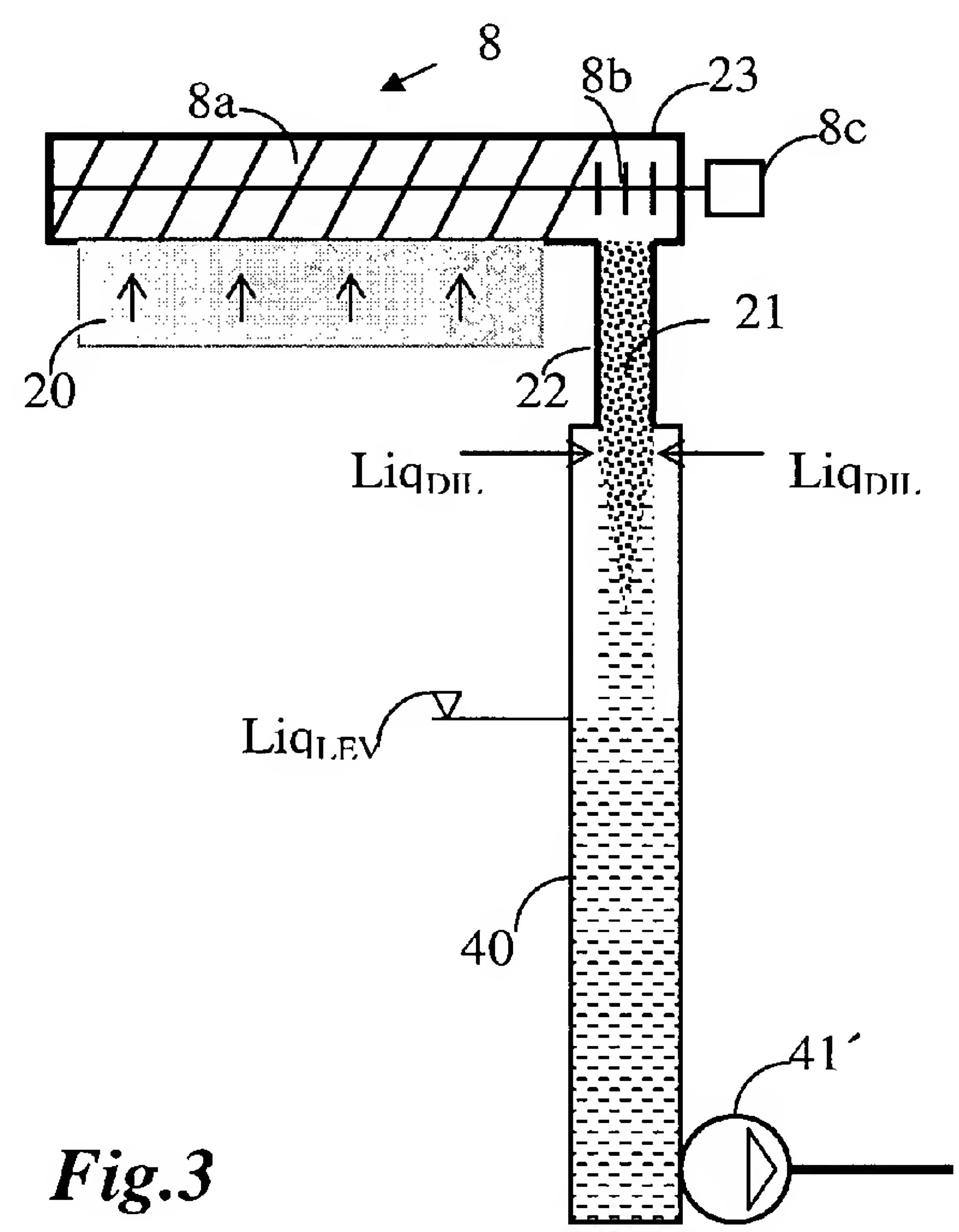

Fig.3

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Description

[0001] The present invention concerns a method according to the preamble of claim 1 and a device according to the preamble of claim 4.

The Prior Art

[0002] In association with either one of the bleaching and the delignification of cellulose pulp in bleaching lines, the pulp passes between different treatment steps in which the pulp is subjected to bleaching or the delignifying effect of various treatment chemicals. The treatment typically alternates between alkaline and acidic treatment steps in which typical sequences may be of ECF type (elemental chlorine-free, Cl, in which chlorine dioxide may be used) such as O-D-E-D-E-D, O-D-PO or sequences of TCF-type (totally chlorine-free) such as O-Z-E-P. Other bleaching steps, such as Pa steps and H steps may be used.
The treatment steps may take place either at medium consistency (8-16%) or at high consistency (≥ 30%), but it is vitally important to wash out after each treatment step degradation products and lignin precipitated during the treatment step and to reduce to a minimum the remaining fraction of fluid, since the latter will otherwise lead to an increased requirement for pH-adjusting chemicals for the subsequent treatment steps and transfer of precipitated lignin and other degradation products, which subsequent step generally takes place at a completely different pH.
[0003] Simple vacuum filters with dewatering drums that are partially (typically 20%-40%) immersed in the pulp suspension that is to be dewatered were used in certain older types of washing step after a bleaching step or a delignification step. In these vacuum filters, a bed of pulp forms spontaneously against the outer surface of the drum under the influence of a negative pressure in the interior of the drum, and the pulp bed is drawn up from the pulp suspension by the rotation of the drum and is scraped off with a scraper on the side of the drum that is moving downwards. A consistency higher than 8-14% is generally never achieved for the pulp bed that has been dewatered, due to the limited degree of dewatering that is achieved, and the dewatered pulp that is scraped of can be readily formed to a slurry with a low consistency again in a subsequent collecting trough. The technique used here is a lower degree of dewatering followed by slurry formation with a cleaner filtrate, and this takes place in a series of vacuum filters in order to achieve the required washing effect. For this reason, it is attempted to achieve as high a degree of dewatering as possible before the dewatered pulp is again formed to a slurry with cleaner filtrate before the subsequent treatment stage.
[0004] A dominating washing machine on the market for bleaching lines is the conventional dewatering press, or thickening press, in which pulp is applied to at least one outer surface of the dewatering drum and subsequently passes a nip between the drums and acquires a consistency of 30% or greater after the nip. A practical upper limit lies at 35-40%, where a higher degree of dryness cannot be achieved without affecting the strength properties of the fibres negatively. A representative washing press of this type is disclosed in the patent US 6,521,094.
The dewatered mat of cellulose pulp that is fed out from the washing machine's nip must first be shredded due to the high degree of dewatering, which shredding takes place in a shredder screw.
The purpose of the shredder screw has been exclusively to break up the mat of dewatered cellulose pulp and feed it onwards to equipment in which the cellulose pulp is rediluted to a consistency that makes it possible to pump it onwards to the next treatment step.
The redilution thus preferably takes place in association with adjustment of the pH, which after an alkaline wash normally involves the addition of powerful acidifiers, or the addition of acidic return water/filtrate from subsequent process steps, before the subsequent acidic treatment step. These acidic conditions have involved the dilution in general being held well separated from the previous alkaline wash as well as the associated shredder screw, since the alkaline wash can be built from simpler material than that which is normally required for washing machines that resist acidic conditions. Acidic conditions require material that can resist acids, and this is significantly more expensive that other material.
[0005] Since the pulp on output from the shredder screw has an extremely high degree of dryness, a consistency of 30% or higher, redilution has generally been carried out in at least one separate dilution screw arranged after the shredder screw where the dilution fluid is added under intensive agitation from the dilution screw in order to achieve a suitable homogeneous consistency that makes pumping to the next step possible. The diluted pulp that is achieved after the dilution screw is fed to a stand pipe in the bottom of which a pump is arranged.
The very high consistency of the pulp after the dewatering step has given rise to the belief that dilution to a homogeneous medium consistency cannot take place unless the dilution takes place under the influence of intensive agitation from the dilution screw. A consistency of 30% or higher of the cellulose pulp is experienced as dry and compact. It can be mentioned for the sake of comparison that medium-consistency pulp is so compact that it is just about possible to walk on this pulp, when it is at the upper part of the consistency range.
The use of a dilution screw at this position, however, increases the requirement for energy, it increases investment costs, it raises the requirement for maintenance and it involves a further mechanical treatment of the pulp which has a negative influence on the strength properties of the pulp.

Aim and Purpose of the Invention

[0006] The present invention is intended to remove the above-mentioned disadvantages and is based on the surprising insight that even if the pulp has been dewatered to give a very high consistency, 30% or more, no mechanical agitation at all is required during the dilution provided that the pulp bed has been shredded to give small granules of a suitable size, and provided that the dilution fluid is added evenly over a flow of the granulated pulp.
It has become apparent, surprisingly, that the granulated pulp, despite its high consistency displays the properties of a sponge, and provided that the dilution fluid is added evenly to a passing flow of granulated pulp, that is not tightly packed, a primary homogenised dilution of the pulp takes place that is fully adequate in order for it to be capable of being pumped onwards to the next bleaching step.
[0007] It is sufficient in laboratory experiments with small quantities of well-granulated pulp with a consistency around 30-35% to pour the required amount of fluid to obtain the required consistency into a container with granulated and non-compressed pulp, and the complete mixture has been homogenised to an even consistency after the addition of the fluid totally without mechanical agitation. Observation of the granulated pulp has shown that there lie cavities between the granules, and the fluid rapidly penetrates between the granules through the complete volume of the granules, after which the granules absorb the fluid as sponges.
This primarily homogenised pulp is fully sufficient such that it can be pumped by a subsequent pump, in which a secondary or supplementary homogenisation takes place, and together this ensures that the same degree of homogenisation can be obtained for the subsequent treatment step completely without a dilution screw.
[0008] The principal aim of the invention is thus to redilute pulp from a high consistency of 30% or higher without the use of a dilution screw and without intensive mechanical agitation, which reduces losses in the strength of the pulp.
[0009] A second aim is to reduce operating costs and maintenance costs for the process equipment in the redilution, since no operation of dilution screw is necessary.
A further aim is to reduce the investment cost of the process equipment. A reduction of both operating costs and investment costs in the process equipment entails a reduction in the cost of manufacturing bleached pulp to an equivalent degree, and this saving is multiplied by the number of washing machines that are used in the bleaching line. No less than six washing machines are included in an O-D-E-D-E-D sequence, and thus the reduction in costs can be significant.
[0010] Approximately 50 kW is required solely for the operation of one dilution screw, and the investment cost is approximately SEK 500,000 (depending to a certain extent on requirements on materials, i.e. whether it needs to be acid-resistant or not).
The operating costs per year in an O-D-E-D-E-D bleaching line will be:

6 * 50 kW * SEK 0.20 (the price for an operator in Sweden) * 24 hours * 350

days (the number of operating days per year, excluding stoppages) =

SEK 500,000 SEK per year;

and the investment cost will be:

6 * SEK 500,000 = SEK 3,000,000.

The capital cost for an interest rate of 5% gives an annual cost of SEK 150,000.
In summary, implementation of the invention involves a total annual saving that approaches SEK 650,000-1,000,000 SEK including maintenance costs and building space (frameworks, etc.) in a bleaching line with a capacity of 1,000 tonnes per day.
Furthermore, availability of the mill increases since six machines can be removed, each of which has an MTBF (mean time between failure).
[0011] A further aim is to remove a treatment step between the washing machine and the subsequent pumping, which makes possible a more compact mill and opportunities to place the washing machines at a lower height over the ground in the mill. The washing machines are normally placed at a great height over the ground, and the pulp falls downwards after being washed in the washing machine while it passes through various conditioning steps. If one of these conditioning steps (such as the dilution screw) becomes unnecessary, the building height can be reduced, which in turn gives a saving.
[0012] With these aims, the invention is characterised by the characteristics of claim 1 with respect to the method

according to the invention, and by the characteristics of claim 4 with respect to the device according to the invention.

Description of Drawings

[0013]

Figure 1 shows a typical treatment step for the pulp in a reactor with a subsequent washing press according to the prior art;
Figure 2 shows part of the system in Figure 1 (prior art);
Figure 3 shows a dilution system according to the invention;
Figure 4 shows a detail of Figure 3; and
Figure 5 shows a view seen from underneath in Figure 4, seen at the level of the section A-A.

Detailed Description of Preferred Embodiments

[0014] Figure 1 shows a conventional treatment step for cellulose pulp, hereafter denoted "pulp". The pulp is fed by the pump 1 to a mixer 2 in which necessary treatment chemicals are added. These treatment chemicals can be, for example, oxygen gas, ozone, chlorine dioxide, chlorine, peroxide, pure acid or a suitable alkali for an extraction step, or a mixture of these, and possibly other chemical or additives such as a chelating agent. The pulp is transported after the addition of the necessary chemicals by the mixer 2 to a reactor system 3, here shown in the form of a single-vessel tower 3 of upwards flow. The reactor system can, however, be constituted by simple pipes or by one or several reactors in series, and possibly with the batchwise addition of chemicals between the towers in those cases in which the bleaching processes are compatible and do not require washing between the towers. The treated pulp is fed after treatment in the reactor system 3 to a pulp chute/stand pipe 4, which establishes the buffer volume and static pressure required, to a pump 5 arranged at the bottom of the pulp chute.
The pulp is fed from the pump 5 to a washing machine 7, shown here in the form of a washing press with two drums 7a, 7b. The pulp is applied to the drums, here at the 12 o'clock position, and is led by convergent pulp collectors during the addition of washing fluid (not shown in the drawing) to a final dewatering nip between the drums, from where a mat of dewatered pulp is fed upwards to a shredder screw 8.
The drums in Figure 1 rotate in opposite directions, and the pulp web is dewatered through the outer surface of the drum while the pulp is led approximately 270° around the perimeter of the drum to the nip.
It is an advantage if the washing press is equivalent to that shown in the patent US 6,521,094. However, any other type of dewatering press or washing press with a drum or drums can be used in which a consistency of 30% or greater is achieved, for example a washing press with a single dewatering drum and a resistance roller, or another types of washing press with two dewatering drums.
[0015] The pulp is fed upwards from the nip in the form of a highly compressed mat 20 to a shredder screw 8, whose axis of shredding is arranged essentially parallel with the axes of rotation of the drums. A small oblique mounting of a maximum of 5-10° may, for example, be present if a conical shredder screw is used, where the mat is fed to an inlet slit in the outer casing of a conical shredder screw, where the inlet slit lies parallel with the axes of the drums. The fragmented pulp is led after this shredder screw 8 out from an outlet in the casing of the shredder screw in the flow 21 to a dilution screw 30 that is driven by a motor 31. The dilution screw exposes the pulp to continuous tumbling during the addition of dilution fluid Liq_2, and the pulp is subsequently fed to a stand pipe 40 at its finally conditioned consistency. The pulp can subsequently be pumped from the stand pipe 40 to the next treatment step of similar type in the bleaching line.
Figure 2 shows a part of the same process in a different view in which the shredder screw 8 is oriented in the same direction as the dilution screw 30. In this case it is seen more clearly how the highly compressed mat 20 of dewatered pulp is fed into the shredder screw 8. The shredder screw contains a threaded screw 8a that is driven by a motor 8c, and which may be equipped with a number of impact pegs 8b at the end of its outflow, which pegs further beat and break up the shredded pulp. The fragmented flow 21 of pulp particles is fed to fall under its own weight to the subsequent dilution screw 30.
[0016] Figure 3 shows the dilution system according to the invention in a treatment step that is otherwise equivalent to that shown in Figure 1. The dewatered web of pulp, which has a consistency of 30% or greater, is fed in this case in to the shredder screw 8 in the same way as shown in Figures 1 and 2. However, dilution occurs in the outlet from the shredder screw according to the invention in a significantly simplified manner. It is important that the web/mat 20 of pulp, which has a consistency of 30% or greater, is first fragmented by the shredder screw such that the mat 20 is granulated to a size of granule that has a normal distribution around a dimension in the range 5-40 mm. The granulated pulp is then fed from the outlet of the shredder screw to fall under its own weight in a stand pipe 22 connected to the outer cover of the shedder screw at the end of its outlet. The dilution fluid Liq_{DIL} is subsequently added under pressure

into the stand pipe through a number of fluid jets arranged around the periphery of the stand pipe and above a level Liq_{LEV} of diluted cellulose pulp established in the stand pipe. In the embodiment shown in Figure 3, the upper connection 22 of the stand pipe to the outer casing of the shredder screw has a smaller diameter than the lower part 40' that lies below. The principle is that the pulp falls under the influence of gravity down through the parts 22, 40' of the stand pipe, and its lower part 40' is given a larger diameter in order to be able to establish a suitable buffer volume before the pumping with the pump 41' at a given level of pulp Liq_{LEV} in the stand pipe 22, 40'.
The amount of dilution fluid Liq_{DIL} added establishes a consistency of the cellulose pulp within the range of medium consistency 8-16%, which is a consistency that allows the pulp to be sent onwards using an MC pump.
The amount of dilution fluid that is required in order to establish the consistency at which the pulp is subsequently pumped is constituted to more than 75-90% of the fluid that is added at the said nozzles arranged above the level that has been established in the stand pipe. A certain amount of chemicals such as acidifiers/alkali or chelating agents may be added at the bottom of the stand pipe 22/40', but the principal dilution takes place with the dilution fluid above the pulp level established in the stand pipe.
The cellulose pulp at this medium consistency is fed by the pump 41 onwards from the lower end of the stand pipe to subsequent treatment steps for the cellulose pulp.
The dilution of the pulp from high consistency of 30% or greater at the upper part of the stand pipe to a medium consistency of 8-16% before the pumping from the lower part of the stand pipe takes place in this manner exclusively under the influence of the hydrodynamic effect from the addition of the dilution fluid through the said nozzles.

[0017] Figure 3 and Figure 4 show an embodiment of the manner in which addition of the dilution fluid can be realised. The dilution fluid is added by a pump to a distribution chamber 60 that is arranged concentrically around the stand pipe 22. The pump pressurises the fluid to a suitable level, an excess pressure of approximately 0.1-0.8 bar. Alternatively, high-pressure nozzles can be used, which finely distribute the dilution fluid in the form of fanned plumes of fluid, oriented at a suitable angle relative to the vertical, a suitable angle being 30-90°.

[0018] A number of nozzles 62 are arranged at the bottom of the distribution chamber oriented obliquely downwards, in the direction of flow of the granulate, and inwards towards the centre of the flow. The amount of obliqueness in the mounting is appropriately 45±15° relative to the vertical. The oblique orientation downwards is favourable for achieving an ejecting influence on the granulate flow, and for avoiding the risk that the dilution fluid splashes upwards in the stand pipe.

[0019] A number of nozzles, at least four, are arranged around the stand pipe 22/40', preferably with equal distances between them. With a stand pipe 22 having a diameter of 800-1,500 mm, it is appropriate that 10-40 nozzles are arranged around the periphery of the stand pipe. It is appropriate that the distance between neighbouring nozzles is less than 50-300 mm. If high-pressure nozzles with fan-shaped plumes are used, the nozzles can be arranged with a greater distance between neighbouring nozzles. It is important that the dilution fluid is added evenly around the complete circumference of the flow of granulate and at a sufficiently high pressure in order to penetrate to the centre of the granulate flow. The selection of the pressure is a setting carried out on engineering grounds, considering the properties of the actual nozzles used.

[0020] The invention can be modified in a number of ways within the scope of the claims. The nozzle 62 for the addition of dilution fluid can, for example, be realised as a simple drilled hole through a thick-walled sheet, of thickness at least 8-10 mm. However, specially designed nozzles are preferred for optimal penetration of the flow of granulate and for even distribution around the complete circumference of the flow, which nozzles preferably generate fan-shaped plumes of fluid. Addition of dilution fluid can also take place at a sufficiently high pressure that the dilution fluid more forms a very finely divided mist in the region that the granulated pulp passes.
Addition of dilution fluid takes place in the preferred embodiment in association with an increase in the area of the stand pipe 22 to a lower part 40' of the stand pipe having a larger diameter, but it is not necessary that the addition takes place in association with an increase in area.
A small amount may also be added at the outlet end of the shredder screw, with the addition flow directed down towards the stand pipe. But the dilution is to take place principally through the hydrodynamic mixing effect from the addition of the dilution fluid into the flow of granulate.

Claims

1. A method for the removal of dewatered cellulose pulp from a dewatering press (7) that preferably also contains washing, in which the pulp is applied to at least one outer surface of two counter-rotating dewatering drums (7a, 7b) with an initial consistency of the pulp in the range 4-12% and where the cellulose pulp after the final dewatering nip of the dewatering press is fed out from the nip in the form of a continuous dewatered mat (20) that maintains a consistency of 30% or higher, and in direct connection to the removal of the mat, the mat is fed perpendicularly to a shredder screw (8) whose axis of shredding is arranged essentially parallel to the axes of rotation of the drums

(7a, 7b), and the shredder screw has at least at one end a surrounding outer cover with an outlet for shredded finely divided pulp **characterised in that**

- the mat is finely divided by the shredding of the shredder screw such that the pulp is granulated to a size that is normally distributed around a dimension in the range 5-40 mm,
- the granulated pulp from the outlet of the shredder screw is fed out to fall freely in a stand pipe (22, 40') connected to the outlet end of the outer cover of the shredder screw,
- and that the dilution fluid is added under pressure into the stand pipe through a number of fluid jets (62) arranged around the periphery of the stand pipe and above a level (Liq_{LEV}) of cellulose pulp established in the stand pipe,
- where the amount of added dilution fluid establishes a consistency of the cellulose pulp in the range of medium consistency 8-16% and that this added amount, to more than 75-90%, is added through the said fluid jets (62) arranged above a level (Liq_{LEV}) established in the stand pipe,
- after which the cellulose pulp at this medium consistency is fed onwards to subsequent treatment steps for cellulose pulp by pumping from the lower end of the stand pipe,
- whereby the dilution in the stand pipe of the pulp from a high consistency of 30% or greater at the upper part of the stand pipe to a medium consistency of 8-16% before pumping at the lower part of the stand pipe takes place exclusively under the influence of hydrodynamic effects from the addition of the dilution fluid through the said fluid jets and where no mechanical agitators are arranged between the output of the dry granulate from the shredder screw and the subsequent pumping.

2. The method according to claim 1 **characterised in that**,the addition of dilution fluid from the relevant fluid jets (62) takes place in the form of pressurised fluid jets directed obliquely downwards in the direction of fall of the cellulose pulp in the stand pipe and that the distance between neighbouring nozzles at the periphery of the stand pipe is less than 50-300 millimetre viewed in the direction of the periphery of the stand pipe.

3. The method according to claim 1 **characterised in that** the fluid jets are directed at an angle relative to the vertical and the direction of fall of the granulate of 45 ±15°.

4. A device for the removal of dewatered cellulose pulp from a dewatering press (7) in which the pulp is applied to a relevant outer surface of two counter-rotating dewatering drums (7a, 7b) with an initial consistency of the pulp in the range 4-12% and where the cellulose pulp after the final dewatering nip of the dewatering press is fed out from the nip in the form of a continuous dewatered mat (20) that maintains a consistency of 30% or higher, and in direct connection to the removal of the mat, the mat is fed perpendicularly to a shredder screw (8) whose axis of shredding is arranged essentially parallel to the axes of rotation of the drums (7a, 7b), and the shredder screw (8) has at least at one end a surrounding outer cover with an outlet for shredded finely divided pulp **characterised in that**

- the mat is finely divided by the shredding of the shredder screw (8) such that the pulp is granulated to a size that is normally distributed around a dimension in the range 5-40 mm,
- the granulated pulp from the outlet of the shredder screw is fed out to fall freely in a stand pipe (22/40') connected to the outlet end of the outer cover (23) of the shredder screw,
- and that the dilution fluid (Liq_{DIL}) is added under pressure into the stand pipe through a number of nozzles (62) arranged around the periphery of the stand pipe and above a level (Liq_{LEV}) of diluted cellulose pulp established in the stand pipe,
- where the amount of added dilution fluid (Liq_{DIL}) establishes a consistency of the cellulose pulp in the range of medium consistency 8-16% and that this added amount, to more 50%, preferably to more than 75-90%, is added through the said nozzles (62) arranged above a level (Liq_{LEV}) established in the stand pipe,
- after which the cellulose pulp at this medium consistency is fed onwards to subsequent treatment steps for cellulose pulp by a pump (41) connected to the stand pipe (22/40') at its lower end near to the bottom of the stand pipe,
- and where the dilution in the stand pipe of the pulp from a high consistency of 30% or greater at the upper part of the stand pipe to a medium consistency of 8-16% before pumping at the lower part of the stand pipe takes place exclusively under the influence of hydrodynamic effects from the addition of the dilution fluid through the said nozzles and without the use of mechanical agitators in the stand pipe.

5. The device according to claim 4 **characterised in that** at least four nozzles are arranged around the periphery of the stand pipe, where the distance between neighbouring nozzles is less than 50-300 mm (22/40').

6. The device according to claim 5 **characterised in that** each nozzle is directed in towards the centre of the stand pipe and obliquely downwards at an angle relative to the vertical and the direction of fall of the granulate of $45 \pm 15°$.

7. The device according to claim 6 **characterised in that** all nozzles are connected to a common distribution chamber (60) for dilution fluid, which is pressurised with a pressure-raising means (61).

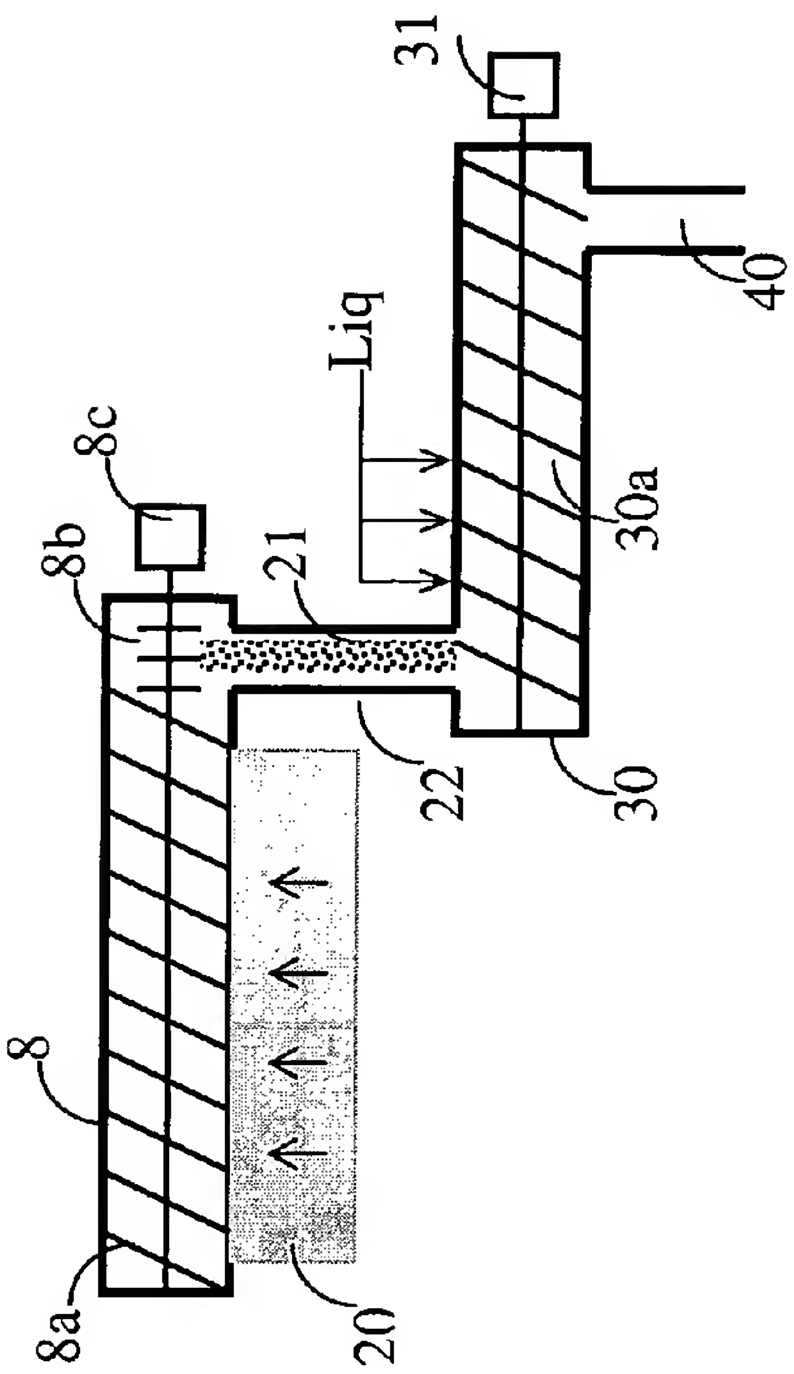

Fig.2

Prior Art

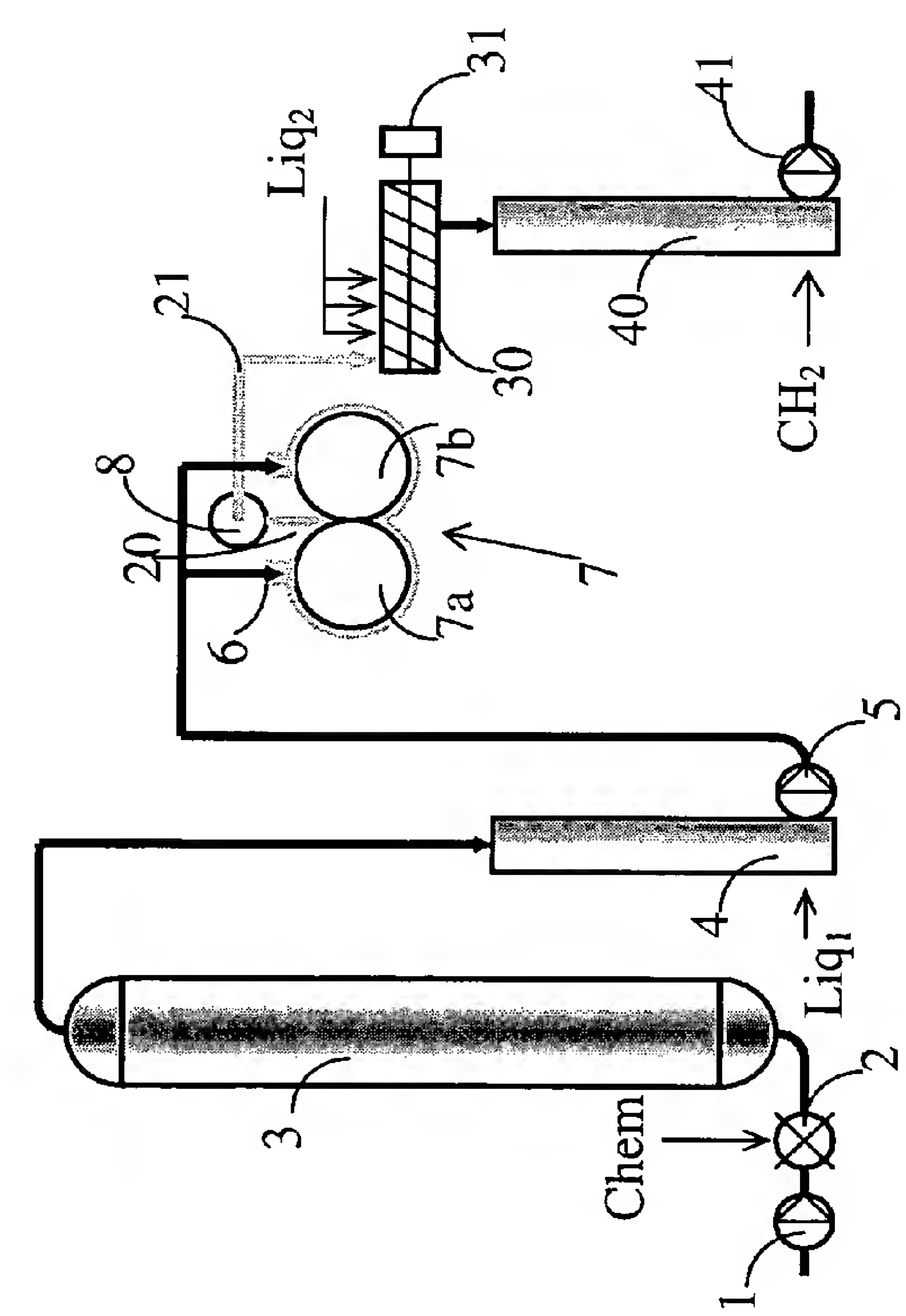

Fig.1

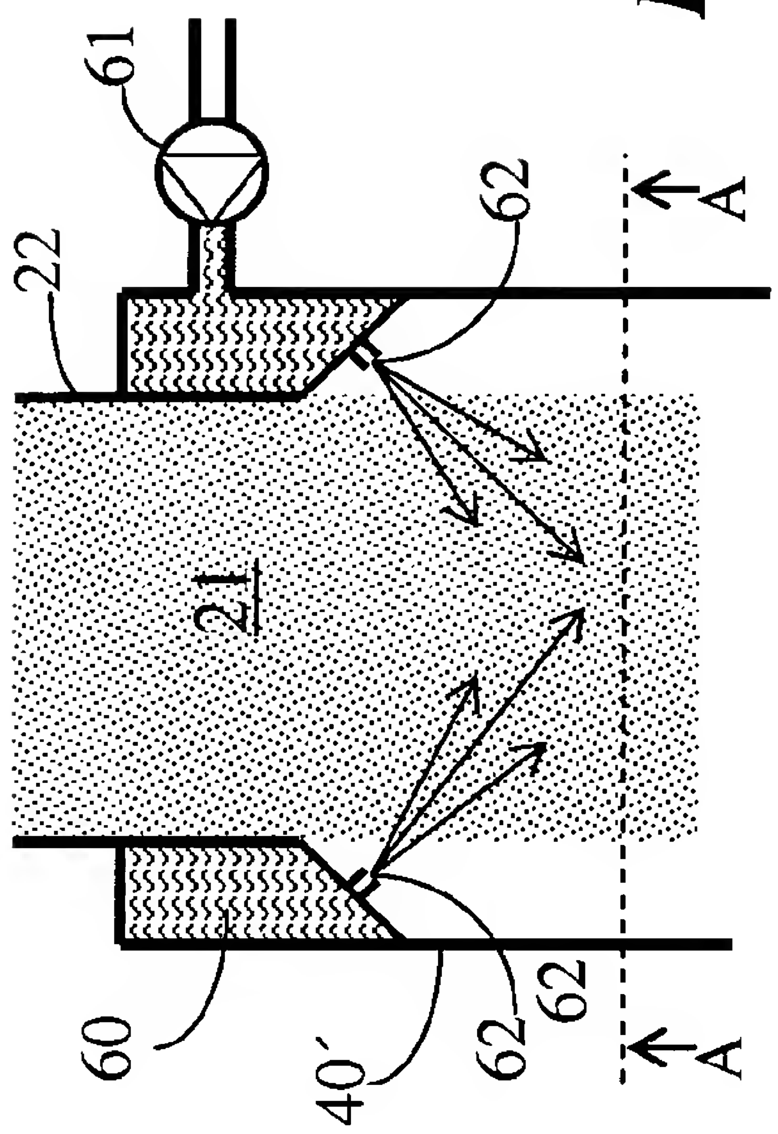

Fig.4

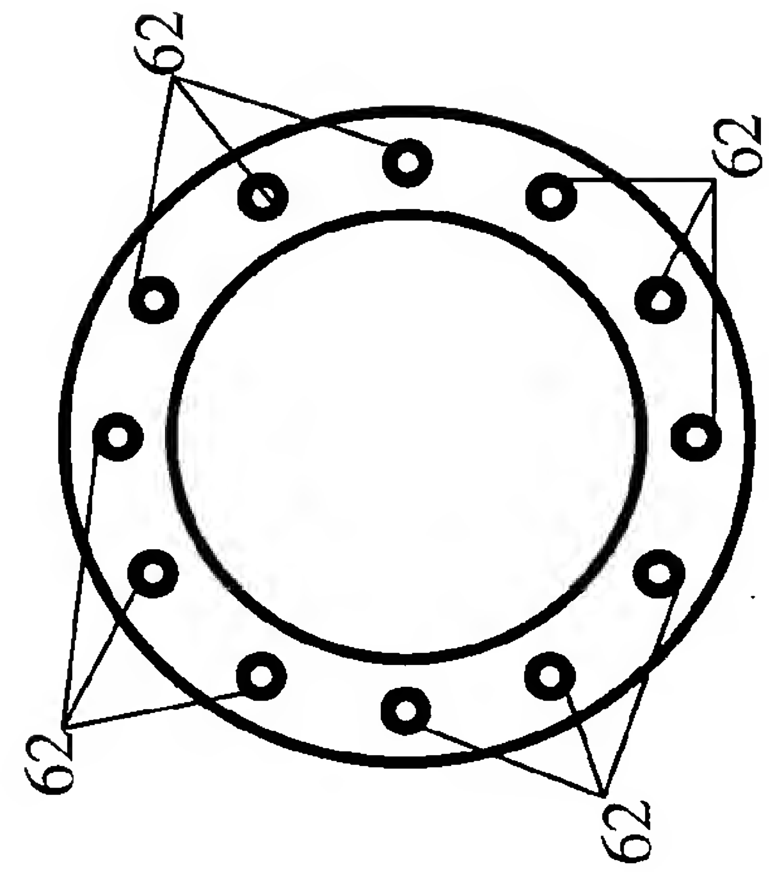

Fig.5

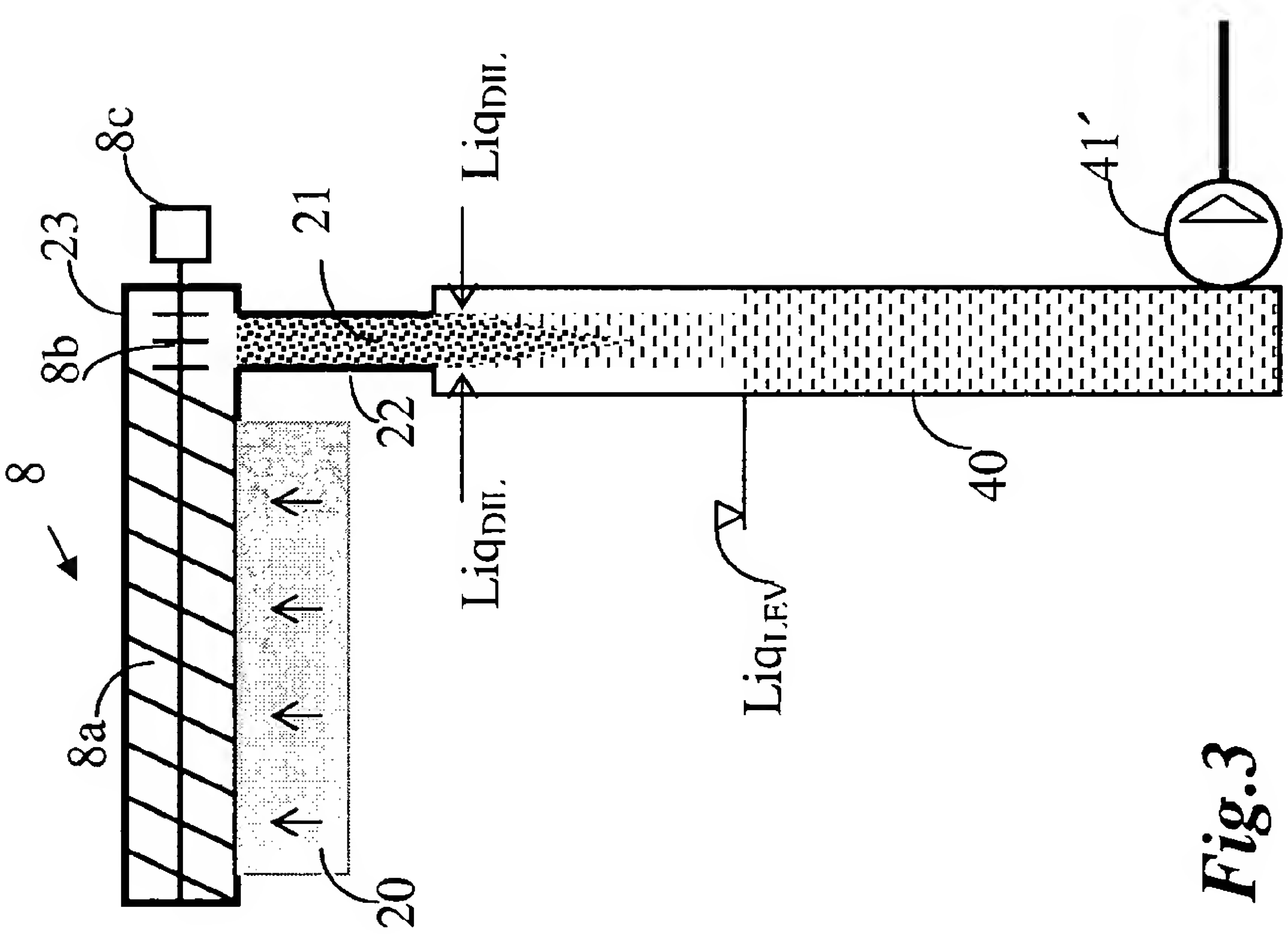

Fig.3

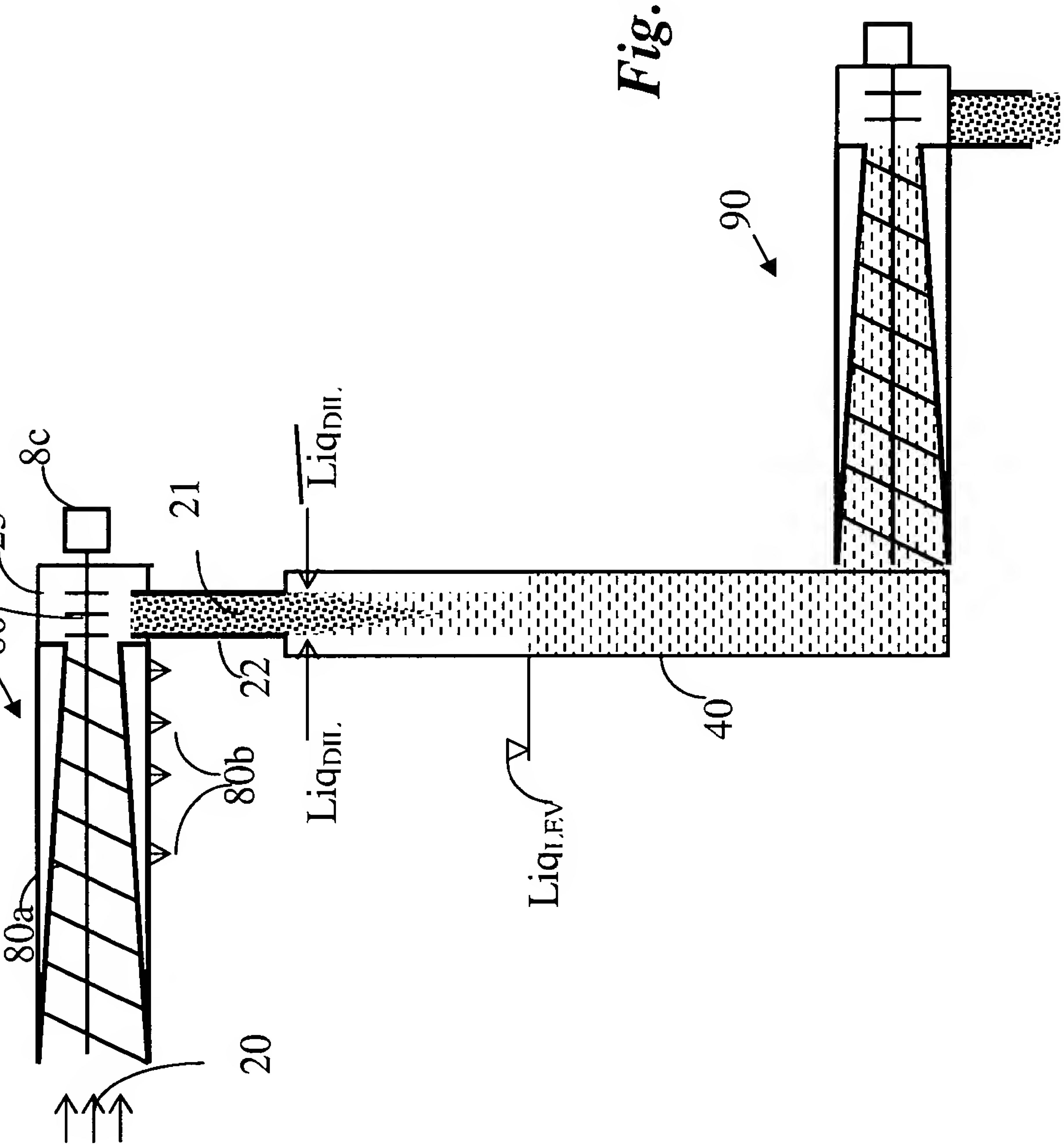

Fig.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5727

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,A	US 2002/043494 A1 (LAMAS AXEL ET AL) 18 April 2002 (2002-04-18) * the whole document * -----	1,4	D21F1/74 D21C9/18 D21C9/06

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

D21F
D21D
D21C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	28 June 2005	Helpiö, T.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 07 5727

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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28-06-2005

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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